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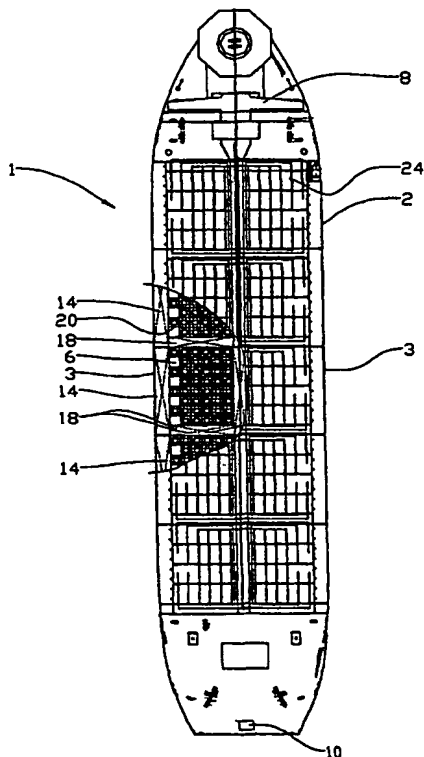
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(54) Title: AN ARRANGEMENT AT A CARGO HOLD OF A SHIP WHERE THE SHIP IS DESIGNED TO TRANSPORT PRESSURISED PETROLEUM PRODUCTS

(57) Abstract: An arrangement at a cargo hold (6) of a ship (1), where the ship (1) is designed to transport and/or store pressurised petroleum products in pressure tanks (22), and where the pressure tanks (22) are less densely packed by the side (3) of the ship (1) than in the central section of the ship (1).



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**Published:**

— *with international search report*

An arrangement at a cargo hold of a ship where the ship is designed to transport pressurised petroleum products

This invention regards the cargo hold of a ship, in particular a cargo hold adapted for pressurised transport of petroleum products, where emphasis is placed on designing the cargo hold and the adjacent sections in a manner such that the risk of damage to the cargo in the case of damage to the ship, is kept at an acceptable level.

Sea transport of gaseous petroleum products has essentially taken place by means of the so-called Liquefied Natural Gas (LNG) method. The method includes cooling of gas to a liquid state, whereupon the gas may be transported in ship's tanks at atmospheric pressure. The method requires substantial investments both at the location of shipment and at the receiving end. As the gas must be cooled to a relatively low temperature, up to a fifth of the gas is used for driving the cooling and heating processes. Consuming this amount of energy solely for transport related processes is expensive and also environmentally questionable.

Several other ship-based solutions have been proposed, where the gas is pressurised and/or cooled in order to achieve a gas density that is expedient for the purpose. Such solutions have gained little practical use, but a solution where a large number of vertical tubular pressure tanks are placed in the cargo hold of a ship, has attracted considerable attention. The method is termed PNG - pressurised natural gas. According to such a method, the gas is compressed at the site of shipment to an overpressure of a couple of hundred bar, and then filled on the pressure tanks located on the ship. The cooling is limited to a simple and inexpensive removal of the heat of compression from the gas, so as to leave the transport temperature near ambient. The great disadvantage of the PNG method is that the gas bottles, if manufactured according to prior art, take up too much of the load capacity of the vessel.

The object of the invention is to remedy the disadvantages of the PNG method for transport of natural gas.

The object is achieved in accordance with the invention by the characteristics stated in the description below and in the appended claims.

According to modern construction and approval standards that allow the best possible use to be made of the mechanical properties of pressure tank materials, greater emphasis is placed on documentation of material properties and construction, and also on periodic inspections of pressurised pipes and vessels, than that which has so far been customary.

As mentioned above, the principal disadvantage of the PNG method is that the net weight of the tanks takes up too much of the load capacity of the ship. The required reduction of the net weight of the tanks can only be achieved by using  
5 relatively high-strength materials combined with construction and certification in accordance with the most appropriate relevant standards. As an example, previously known calculation standards for offshore pipelines may be used. In order to allow the required periodic inspections to take  
10 place, the pressure tanks are arranged in relatively long, vertical cassettes in a way that allows the inspections to be carried out at any time, including during the normal operation of the ship.

The cassettes, which in a preferred embodiment are designed  
15 to comprise eight pressure tanks, are formed as a plate or a truss structure. The pressure tanks are connected to the cassette structure in an appropriate manner, so that net weight and thermal stresses have the smallest possible effect on the pressure tanks. The mutual spacing of the pressure  
20 tanks and the internal structure of the cassette is sufficient to allow access with inspection equipment. Longitudinal welded joints, which generally experience the greatest strain, may be oriented inwards, making them directly accessible from the central cavity of the cassette.

25 The cassettes are designed to be prefabricated, checked and certified prior to being positioned in the cargo hold of a ship. The forces from the net weight of the cassettes and the cargo normally bear on the bottom of the ship. The cargo hold of the ship may be equipped with slides that are  
30 complementary to guides in one or more of the side walls of

the cassette. Thus the cassette may, e.g. while suspended from a crane, be guided onto the slides and lowered to its position in the cargo hold in a controlled manner. The cassette is held in the horizontal position by the same slides/guides.

During the development of said cassettes, it has been necessary to produce an appropriate design for the ship's cargo hold and the adjacent sections in order to ensure that the risk of damaging the pressure tanks in an accident such as e.g. a ship collision, is kept at an acceptably low level.

It is obvious that the greatest danger of serious damage to the pressure tanks exists near the sides of the ship. The pressure tanks are less exposed to damage at the bottom of the ship, as they will be lifted up along their guides if such damage were to occur. Between the ship's sides and the pressure tanks in the ship's cargo hold, relatively wide buffer zones have been provided in the form of bulkheads. The bottom of the ship is also provided with such bulkheads. The ship may also be provided with buffer zones between the groups of pressure tanks in the cargo hold.

In the cargo hold, the pressure tank packing density is at its lowest near the ship's sides and at its highest near the centre line of the ship. The packing density of pressure tanks in the cargo hold may decrease continuously in the direction from the ship's side towards the central section of the ship and/or decrease step by step by one or more layers of pressure tanks near the ship's side having a lower packing density than the pressure tanks located on the inside.

In the case of this type of transport, a piping system must exist for blowing off the pressure tank contents in an emergency. A reduced packing density of pressure tanks near the ship's sides in accordance with the invention makes it possible to simplify the piping system for emergency blowdown of the pressure tanks significantly, as there is a smaller number of pressure tanks within a particular area of the outer walls of the ship, relative to that which would be the case if the ship's cargo hold have a uniform packing density.

10 The following describes a non-limiting example of a preferred embodiment illustrated in the accompanying drawings, in which:

Figure 1 shows a side view of a ship fitted with pressure tanks for transporting petroleum products;

15 Figure 2 shows a plan view of the ship in figure 1, showing a section where the cargo hold hatches have been uncovered in order to illustrate how the pressure tanks have been arranged in the cargo hold;

Figure 3 schematically shows section I-I in figure 1; and

20 Figure 4 schematically shows, on a larger scale, a cutout of the ship in figure 2.

In the drawings, reference number 1 denotes a ship adapted for transport of pressurised petroleum products, comprising a hull 2 with sides 3, a bottom 4, a cargo hold 6, a superstructure 8 and a flare tower 10. The cargo hold 6 is fitted with hatches 12.

The ship's 1 hull 2 is provided with side buffer bulkheads 14 at the sides 3 and bottom buffer bulkheads 16 at the bottom 4. The cargo hold 6 has buffer zones 18 between groups of cassettes 20. The cassettes 20 each comprise a number of pressure tanks 22, the pressure tanks 22 being connected to the flare tower 10 by means of pipework 24 and valves (not shown).

The cassettes 20, and thus the pressure tanks 22, are arranged with a lower packing density near the ship's 1 sides 3 than at the central section 26 of the ship 1, see figure 4.

If one of the ship's 1 sides 3 were to be damaged, deformation will first occur at one or more of the side buffer bulkheads 14. Then the section of the hold 6 located near the side buffer bulkheads 14 will be deformed, in which section the pressure tanks 22 have the lowest packing density. In the case of more serious damage resulting in the pressure vessels 22 moving in the hold 6, the buffer zones 18 of the hold 6 will be able to act as spaces into which the pressure vessels 22 may be displaced without sustaining unwarranted deformation. If the bottom 4 of the ship 1 is damaged to a greater extent than that which can be taken up by the ship's 1 bottom buffer bulkheads 16, the pressure tanks will be displaced upwardly in the cargo hold 6.

Thus this ship design with buffer bulkheads 14, 16, buffer zones 18 and a relatively lower packing density of pressure tanks 22 near the sides 3 of the ship 1 will, in the case of damage to the ship 1, reduce the risk of unacceptable damage to a significant degree, when compared with the use of cargo holds according to prior art.



In this preferred example embodiment, the pressure tanks 22 are disposed vertically in cassettes 20 in order to make it easy to lift them out for inspection and maintenance.

However, the invention is equally well suited for pressure  
s tanks disposed horizontally and essentially parallel to the longitudinal axis of the ship 1.

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## C l a i m s

1. An arrangement at a cargo hold (6) of a ship (1), where the ship (1) is designed to transport and/or store pressurised petroleum products in pressure tanks (22),  
5 c h a r a c t e r i s e d i n that the pressure tanks (22) have a lower packing density by the ship's (1) side (3) than in the central section (26) of the ship (1).
2. An arrangement in accordance with Claim 1,  
c h a r a c t e r i s e d i n that the sides (3) of  
10 the ship (1) are fitted with side buffer bulkheads (14).
3. An arrangement in accordance with one or more of the preceding claims, c h a r a c t e r i s e d i n that the bottom (4) of the ship (1) is fitted with bottom buffer bulkheads (16).
- 15 4. An arrangement in accordance with one or more of the preceding claims, c h a r a c t e r i s e d i n that the ship's (1) hold (6) is provided with buffer zones (18).
5. An arrangement in accordance with one or more of the  
20 preceding claims, c h a r a c t e r i s e d i n that the pressure tanks (22) are disposed essentially vertically.
6. An arrangement in accordance with one or more of the preceding claims, c h a r a c t e r i s e d i n that

the pressure tanks (22) in the ship (1) are arranged in cassettes (20).

7. An arrangement in accordance with one or more of the preceding claims, characterised in that  
5 the cassette (20) is connected to the ship's (1) structure in a manner that allows it to be displaced in the vertical direction.

8. An arrangement in accordance with one or more of the preceding claims, characterised in that  
10 the packing of the pressure tanks (22) in the ship (1) is arranged by cassette.

9. An arrangement in accordance with one or more of the preceding claims, characterised in that  
15 side buffer bulkheads (14) are provided in the ship's (1) sides (3).

10. An arrangement in accordance with one or more of the preceding claims, characterised in that  
bottom buffer bulkheads (16) are provided in the bottom (4) of the ship (1).

20 11. An arrangement in accordance with one or more of the preceding claims, characterised in that  
buffer zones (18) are provided between groups of pressure tanks (22) in the ship's (1) hold.

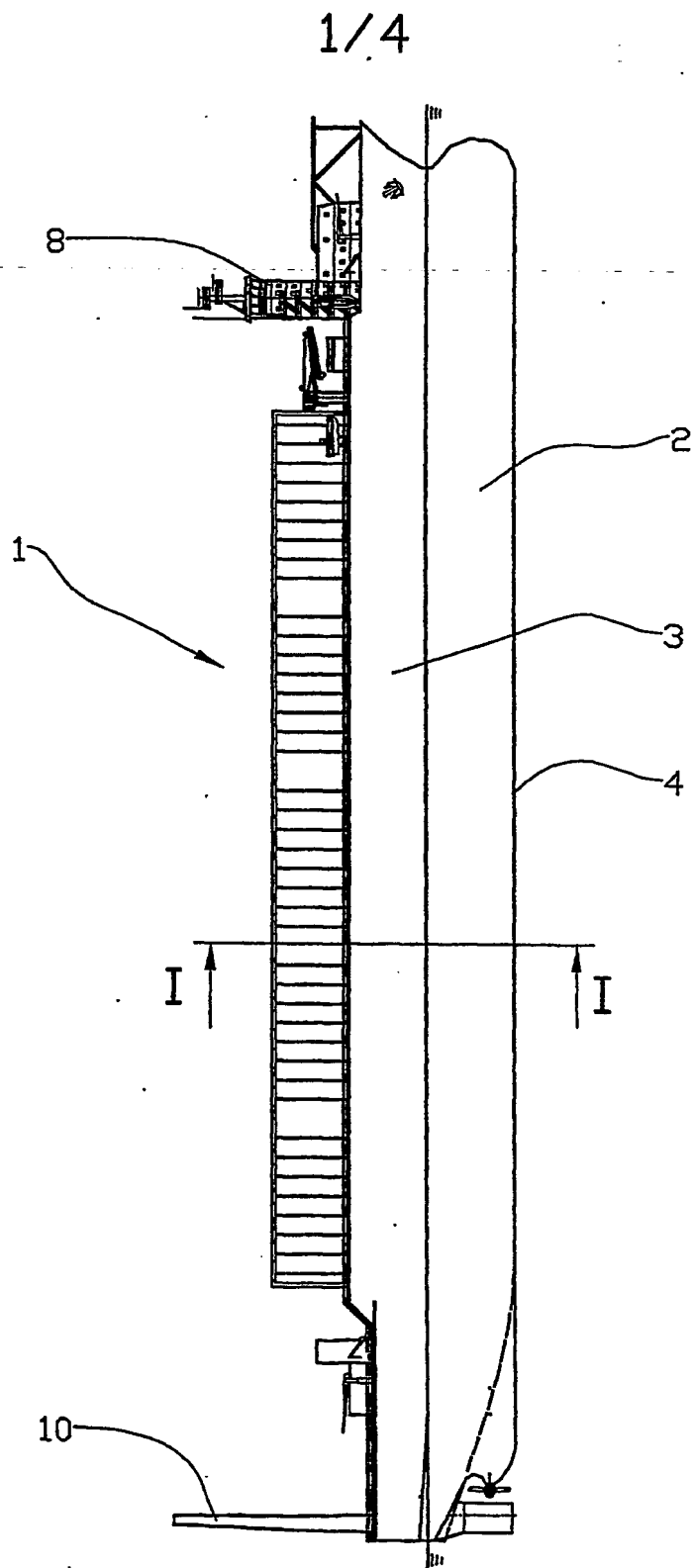


Fig. 1

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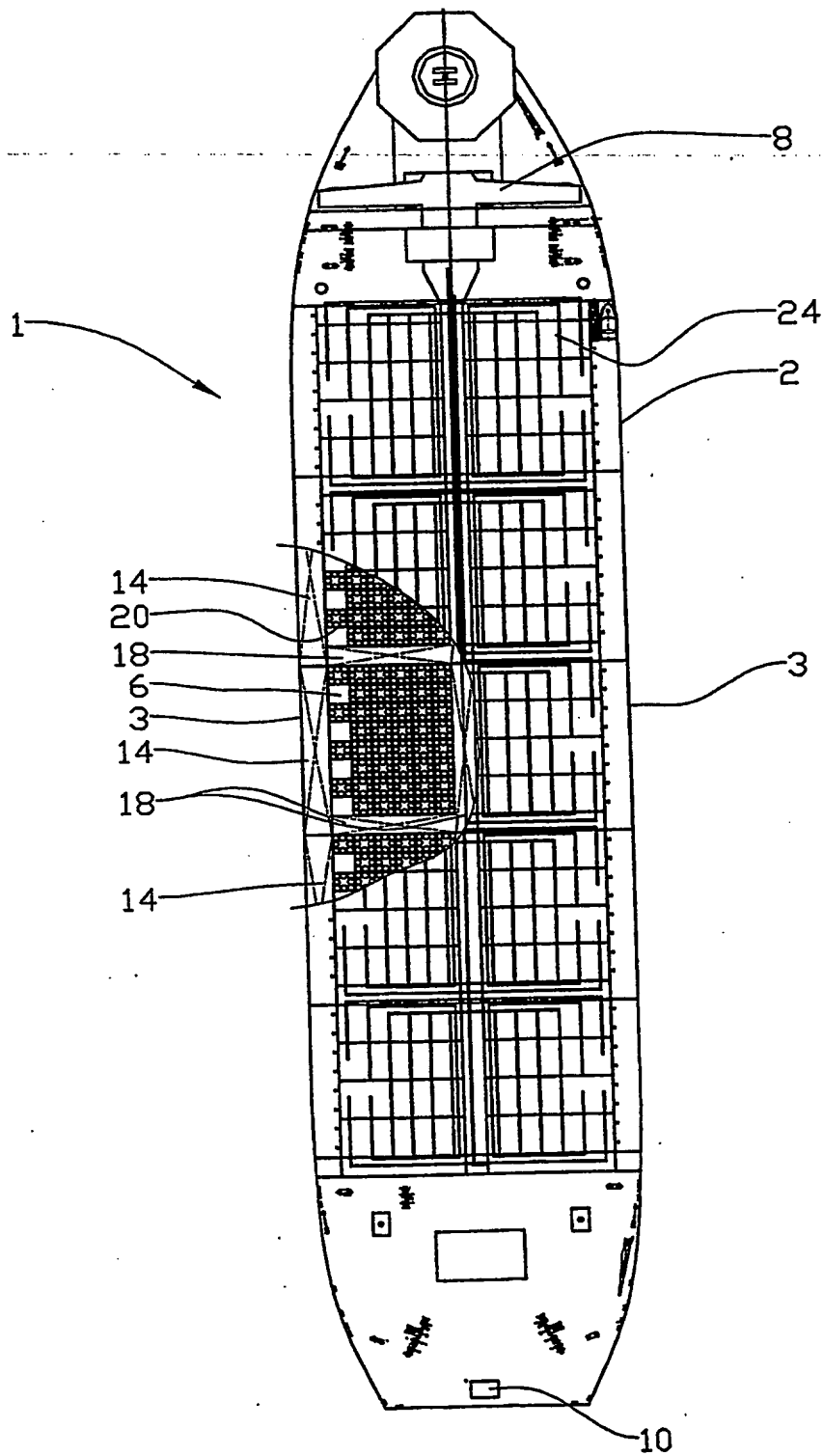
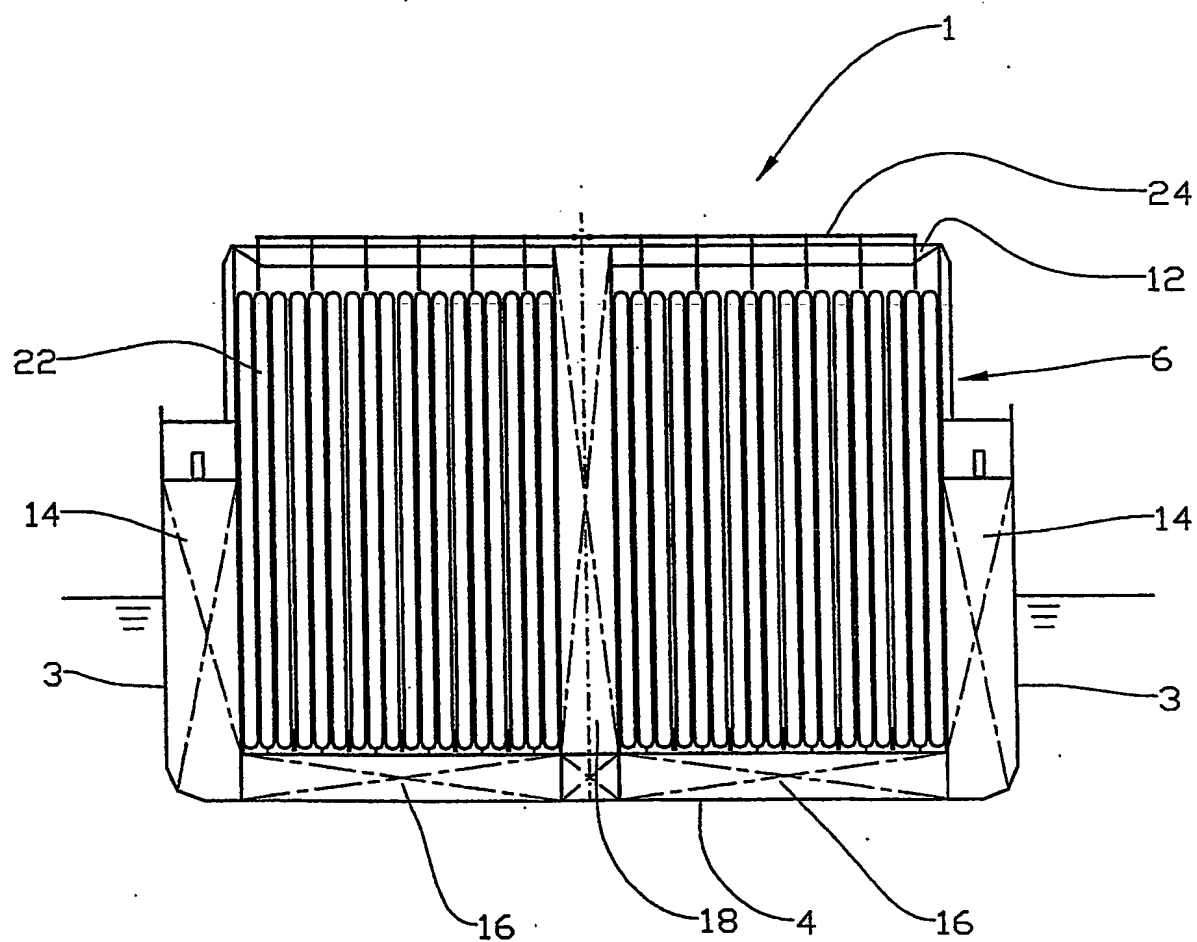


Fig. 2

3/4



I-I

Fig. 3

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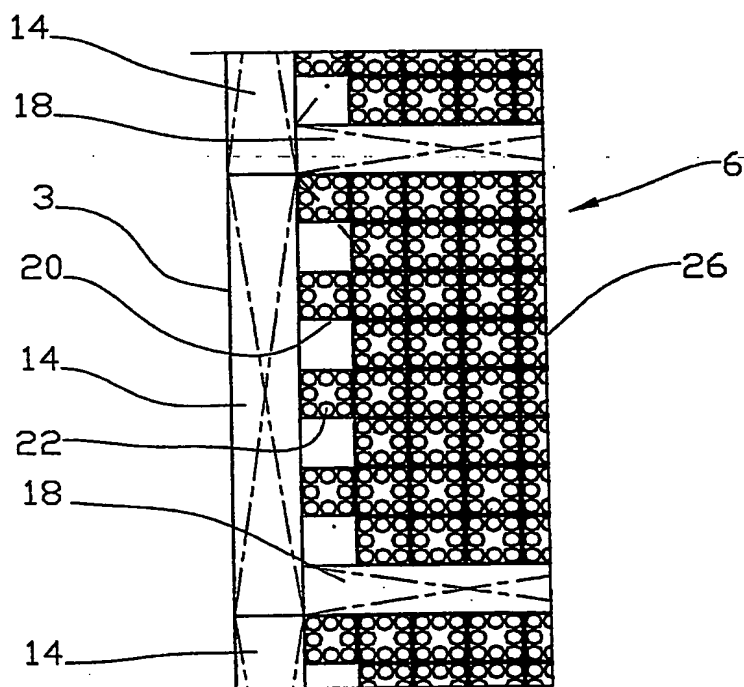


Fig. 4

## INTERNATIONAL SEARCH REPORT

International application No.

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## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B63B 25/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2721529 A (R A JAHNSEN), 25 October 1955 (25.10.55), figures 1,2, claim 1	1
Y	--	2-11
Y	US 3830180 A (BOLTON), 20 August 1974 (20.08.74), column 2, line 62 - column 3, line 33, figures 11, 12, claim 1, abstract	2-11
P,A	WO 02066316 A1 (KNUTSEN OAS SHIPPING AS), 29 August 2002 (29.08.02), figures 1-3, abstract	6,8
	--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 9716678 A1 (ENRON LNG DEVELOPMENT CORP), 9 May 1997 (09.05.97), figures 2,3, abstract</p> <p style="text-align: center;">-- -----</p>	1

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

30/12/02

International application No.

PCT/NO 02/00462

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	2721529	A	25/10/55	DE	870508 C	16/03/53
				FR	1042520 A	02/11/53
				GB	693156 A	24/06/53
-----						
US	3830180	A	20/08/74	NONE		
-----						
WO	02066316	A1	29/08/02	NO	313846 B	09/12/02
				NO	20010728 A	14/08/02
-----						
WO	9716678	A1	09/05/97	AU	716813 B	09/03/00
				AU	7280596 A	22/05/97
				BR	9607554 A	07/07/98
				CA	2198358 A	01/05/97
				CN	1062062 B	14/02/01
				CN	1183829 A	03/06/98
				EG	22042 A	30/06/02
				EP	0858572 A	19/08/98
				IL	123547 D	00/00/00
				JP	2000500550 T	18/01/00
				NO	981347 A	25/03/98
				NZ	320555 A	28/01/99
				PL	182179 B	30/11/01
				PL	326938 A	09/11/98
				RU	2145689 C	20/02/00
				TR	9800689 T	00/00/00
				US	5803005 A	08/09/98
				US	5839383 A	24/11/98
				US	6003460 A	21/12/99
				ZA	9609094 A	29/04/98
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